Journal MVZ Cordoba
2019; 24(3):7322-7327.
https://doi.org/10.21897/rmvz.1824

Research article

Reduction of the crude protein in the diet of creole broilers in a semi-intensive system

Cátia Borges-Ferreira[1*] Ph.D; Sandra Regina Freitas-Pinheiro[1] Ph.D; Dayane Josiane-Vieira[1] M.Sc; Júlio Almeida-Silva[1] M.Sc, Renata Gomes-Oliveira[1] M.Sc; Rúbio Madureira de Souza-Carvalho[1] M.Sc.

[1]Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), Programa de Pos- Graduación en Zootecnia. Diamantina, MG, Brasil. CEP:39100-000.
*Correspondence: sandrafreitaspinheiro@gmail.com

Received: June 2019; Accepted: July 2019; Published: September 2019.

ABSTRACT

Objective. To evaluate the reduction of crude protein levels, without altering the ratio of essential amino acids, of free-range chickens, of one at 42 days old. **Materials and methods.** Two trials were performed comprising the initial phase (one to 21 days) and growth (22 to 42 days). A total of 630 chicks of the Redbro line of one day old, were distributed in a completely randomized design with five treatments and six replicates of 21 birds each, totaling 30 experimental units consisting of a shelter area and corrals. The levels reduced of crude protein for the initial phase were: 21.5, 21.0, 20.5, 20.0 and 19.5% and for the growth phase: 19.0, 18.5, 18.0, 17.5 and 17.0%. In all the treatments were maintained the minimum ratio between essential amino acids and lysine. The performance characteristics evaluated were: weight gain, feed intake and feed conversion. **Results.** There was no effect ($p>0.05$) of the crude protein reduction for any of the variables in all phases, except for feed conversion ($p<0.05$) that improved with 18.20% in the growth phase. **Conclusions.** Crude protein levels for chickens of the Redbro line, can be reduced to 19.5% and 18.2% for the initial and growth phases, respectively, provided that the ideal amino acid ratios are maintained with digestible lysine and meet the requirements of limiting amino acids.

Keywords: Essential amino acids, ideal protein, Label rouge, nutrition (*Source: MeSH, NLM*).

RESUMEN

Objetivo. Evaluar la reducción de los niveles de proteína bruta sin alterar la relación de aminoácidos esenciales en pollos de engorde criollos de uno a 42 días de edad. **Materiales y métodos.** Se realizaron dos ensayos que comprendieron la fase inicial (un a 21 días) y crecimiento (22 a 42 días). Se utilizaron 630 pollos de la línea Redbro de un día de edad, distribuidos en un diseño completamente al azar, con cinco tratamientos y seis repeticiones de 21 aves cada una, totalizando 30 unidades experimentales distribuidas en corrales con abrigo. Los niveles reducidos de la proteína bruta para la fase inicial fueron: 21.5; 21.0; 20.5; 20.0 y 19.5% y para la fase de crecimiento: 19.0; 18.5; 18.0; 17.5 y 17.0%. En todos los tratamientos se mantuvo la proporción mínima entre aminoácidos esenciales y lisina. Las características de desempeño evaluadas fueron: ganancia de peso, consumo de ración y conversión alimenticia. **Resultados.** No hubo diferencia ($p>0.05$) en la reducción de proteína bruta para ninguna de las variables en todas las fases, excepto para conversión alimenticia ($p<0.05$) en la fase de crecimiento que mejoró con 18.2% de proteína bruta. **Conclusiones.** Los niveles de proteína bruta para pollos criollos de engorde de la línea Redbro, pueden ser reducidos a 19.5 y 18.2% para la fases inicial y de crecimiento, respectivamente, siempre cuando se mantengan las relaciones adecuadas de aminoácidos con lisina digestible y se atiendan las exigencias de los aminoácidos limitantes.

Palabras clave: Aminoácidos esenciales, Label rouge, nutrición, proteína ideal (*Fuente: MeSH, NLM*).

How to cite (Vancouver)
Borges-Ferreira C, Freitas-Pinheiro SR, Josiane-Vieira D; Almeida-Silva J, Gomes-Oliveira R, Souza-Carvalho R. Reduction of the crude protein in the diet of Creole broilers in a semi-intensive system. Rev MVZ Cordoba. 2019; 24(3):7322-7327. DOI: https://doi.org/10.21897/rmvz.1824

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ISSNe: 1909-0544

INTRODUCTION

The breeding of free-range chickens for meat production with better features such as an animal welfare, food safety, sensory quality of the product and the concern with environment is a promising alternative aviculture segment.

Knowing that the requirements for broiler are essential amino acids and sufficient amounts of nitrogen for the synthesis of crude protein Skalan and Plavnik (1) suggest that diets for broilers should be formulated to provide sufficient amino acids for protein synthesis, since that excessive consumption of amino acids can result in decrease in the efficiency of utilization and increased requirement for essential amino acids. That happens because of the excess protein is catabolized in the form of uric acid and this process has a high energy cost. Thus, the use of lower protein levels, using the concept of ideal protein, can produce a better use of nitrogen by birds and decrease the excretion of this element in the environment.

When Bregendahl et al (2) measured the effect of diets with low protein on performance and body composition of broilers in the initial phase, observed that broiler fed food containing low protein excreted less nitrogen.

However, not so many researches to evaluate the protein requirements for free-range chickens reared in a semi confined system. Whereas their requirements of protein may differ from those of chickens, this research was conducted with the objective of to evaluate the reduction of crude protein, without altering the ratio of essential amino acids, of free-range chickens, in the early periods (1 to 21 days) and growth (22 to 42 days).

MATERIAL AND METHODS

Location. The experiment was conducted in June and August of 2012 at the Poultry Sector of the Department of Animal Science, Federal University of the Jequitinhonha and Mucuri Valleys, Diamantina, Minas Gerais, Brazil.

Experimental units. The area of the shed of each experimental unit was (4 m^2) with a height of 2.5 m, covered by asbestos cement tiles, and fenced with mesh and curtains, cement floor and cisco lined (±5 cm thick), with manual feeders and drinkers. The grazing area was (3 m^2/bird) were surrounded by galvanized wire meshes and covered by Tifton 85 grass, which characterized a semi-confined system.

During the initial phase (1 to 21 days), the birds were housed in the boxes and the heating was done with infrared lamps of 250 watts. For the next phase (22 to 42 days), the birds had access to the grazing area, from day 28, being released from 8:00 to 18:00 h. These birds were raised under the same conditions until day 21 and then transferred to their respective experimental units, these birds received diets formulated to meet their requirements, accordance with the recommendations of Rostagno et al (3).

The mean maximum and minimum temperature recorded inside the house were 28.5 and 32.5°C for the initial phase and for the growth phase were 26.5 and 29°C, respectively.

Animals, diets and experimental design. A total of 630 chickens male free-range of the Redbro line were distributed in a completely randomized design with five treatments and six replicates of 21 birds per treatment.

For each experimental, diets were formulated, composed mainly of corn and soybean meal, to be isoenergetic and to meet all the nutritional requirements of chickens. The diets were formulated following the nutritional tables of Rostagno et al (3) for chickens of regular performance, except for crude protein. On the other hand, the calculations described by Nagib et al (4), Pinheiro et al (5) and Pinheiro et al (6) were respectively used to meet the nutritional requirements of digestible lysine, phosphorus and calcium.

Decreasing levels of dietary crude protein (treatments) were of 21.5, 21.0, 20.5, 20.0 and 19.5%, and 19.0, 18.5, 18.0, 17.5 and 17.0% for the initial (Table 1) and growth (Table 2) periods, respectively. The levels of crude protein were obtained by adjusting the amounts of corn, soybean meal and corn gluten. In all the treatments were maintained the minimum ratio between essential amino acids and lysine using the supplementation of industrial amino acids, as was proposed by Rostagno et al (3). During the first 5 days of life, all chickens received a vitamin complex diluted in water.

Performance. The performance parameters evaluated were: weight gain (g/bird), feed intake (g/bird) and feed conversion (g feed intake/g weight gain) corrected for mortality. The birds were weighed at the beginning and end of each experiment for the determination of weight gain. The birds were subjected to 12 hours fasting before the slaughter. Difference between offered and leftovers diet in each experiment was used to obtain the feed intake. The relationship between feed intake and weight gain was used to calculate the feed conversion.

Table 1. Percentage compositions of the experimental diets for free-range chickens during the initial period (from 1 to 21 days).

Ingredients	Crude Protein (%)				
	21.50	**21.00**	**20.50**	**20.00**	**19.50**
Corn	57.951	59.732	61.033	62.563	65.252
Soybean meal 45%	35.716	34.175	33.458	31.712	29.250
Dicalcium phosphate	1.522	1.529	1.535	1.542	1.551
Soybean oil	1.571	1.247	1.123	0.749	0.203
Corn glúten meal (60%)	1.127	1.142	0.634	0.779	1.359
Limestone	1.221	1.225	1.225	1.230	1.237
Salt	0.494	0.494	0.494	0.494	0.494
Vitamin premix[1]	0.100	0.100	0.100	0.100	0.100
Mineral premix[2]	0.050	0.050	0.050	0.050	0.050
DL-methionine (99%)	0.154	0.166	0.182	0.193	0.201
L-lysine (78.0%)	0.004	0.050	0.077	0.128	0.198
L-threonine (99%)	0.000	0.000	0.000	0.000	0.016
Choline chloride (60%)	0.040	0.040	0.040	0.040	0.040
Antioxidant[3]	0.050	0.050	0.050	0.050	0.050
TOTAL	100.00	100.00	100.00	100.00	100.00
Calculated Composition					
Crude protein (%)	21.50	21.00	20.50	20.00	19.50
Metabolizable energy (kcal/kg)	2952	2952	2952	2952	2952
Calcium (%)	0.950	0.950	0.950	0.950	0.950
Available phosphorus (%)	0.394	0.394	0.394	0.394	0.394
Sodium (%)	0.215	0.215	0.215	0.215	0.215
Digestible methionine+ cysteine (%)	0.750	0.750	0.750	0.750	0.750
Digestible methionine (%)	0.449	0.455	0.462	0.468	0.473
Digestible lysine (%)	1.041	1.041	1.041	1.041	1.041
Digestible threonine (%)	0.738	0.720	0.702	0.682	0.677
Digestible arginine (%)	1.350	1.308	1.280	1.234	1.174
Digestible tryptophan (%)	0.239	0.231	0.226	0.217	0.206
Digestible valine (%)	0.925	0.901	0.877	0.853	0.828

[1] Values per kg of feed: Vitamin A - 12 million IU, vit. D3 – 2.200,000 IU, vit. E – 30 g, vit. B1 - 2.2 g, vit. B2 - 6 g, vit. B6 - 3.3 g, vit. B12 – 0.016 mcg Pantothenic Acid - 13 g, vit. K ¬ 3 to 2.5 g, folic acid – 1 g, antioxidant – 100.000 mg and vehicle qsp – 1.000 g.
[2] Manganese, 75.000 mg, iron, 50.000 mg, zinc, 70.000 mg, copper, 8.500 mg, cobalt, 200 mg, iodine, 1.500 mg and vehicle qsp 1000 g.
[3] Butylated Hydroxy Toluene.

Statistical analysis. Analysis of variance, including the fixed effect of the levels of dietary crude protein in model, was performed using the Statistical Analysis System software (7). When have significant effect ($p<0.05$) was detected, an analysis of regression was then performed. Linear, Linear Response Plateau (LRP) or quadratic models ($\beta1$ or $\beta2 \neq 0$, respectively; $p<0.05$) were chosen based on the coefficients of determination (R^2).

Ethics committee and biosafety. The experiment was approved by the Ethics Committee on the Use of Animals (ECUA) number: 005/11 of the Federal University of the Jequitinhonha and Mucuri Valleys, Diamantina, Minas Gerais, Brazil.

Table 2. Percentage compositions of the experimental diets for free-range chickens during the growth period (from 22 to 42 days).

Ingredients	Crude Protein (%)				
	19.00	**18.50**	**18.00**	**17.50**	**17.00**
Corn	63.375	65.172	66.989	69.118	71.328
Soybean meal 45%	30.436	28.872	27.256	25.266	23.184
Dicalcium phosphate	1.327	1.335	1.342	1.353	1.363
Soybean oil	2.620	2.294	1.972	1.596	1.208
Limestone	1.197	1.201	1.205	1.209	1.213
Salt	0.457	0.456	0.456	0.456	0.456
Vitamin premix[1]	0.100	0.100	0.100	0.100	0.100
Mineral premix[2]	0.050	0.050	0.050	0.050	0.050
DL-methionine (99%)	0.208	0.221	0.234	0.250	0.268
L-lysine HCl (78.0%)	0.134	0.181	0.230	0.291	0.355
L-tryptophan (99%)	0.000	0.000	0.000	0.000	0.012
L-threonine (99%)	0.006	0.026	0.047	0.072	0.100
L-arginine (93.1%)	0.000	0.000	0.000	0.055	0.118
L-valine (96.5%)	0.000	0.002	0.029	0.061	0.097
L-isoleucine (96.5%)	0.000	0.000	0.000	0.033	0.069
Choline chloride (60%)	0.040	0.040	0.040	0.040	0.040
Antioxidant[3]	0.050	0.050	0.050	0.050	0.050
TOTAL	100.00	100.00	100.00	100.00	100.00
Calculated Composition					
Crude Protein (%)	19.00	18.50	18,00	17.50	17.00
Metabolizable energy (kcal/kg)	3075	3075	3075	3075	3075
Calcium (%)	0.881	0.881	0,881	0.881	0.881
Available phosphorus (%)	0.351	0.351	0,351	0.351	0.351
Sodium (%)	0.200	0.200	0,200	0.200	0.200
Digestible methionine + cysteine (%)	0.734	0.734	0,734	0.734	0.734
Digestible methionine (%)	0.466	0.473	0,479	0.487	0.497
Digestible lysine (%)	1.006	1.006	1,006	1.006	1.006
Digestible threonine (%)	0.654	0.654	0,654	0.654	0.654
Digestible arginine (%)	1.180	1.136	1,091	1.087	1.087
Digestible tryptophan (%)	0.208	0.200	0.191	0.181	0.181
Digestible valine (%)	0.808	0.785	0.786	0.785	0.785

[1] Values per kg of feed: Vitamin A - 12 million IU, vit. D3 – 2.200.000 IU, vit. E - 30 g, vit. B1 - 2.2 g, vit. B2 - 6 g, vit. B6 - 3.3 g, vit. B12 – 0.016 mcg Pantothenic Acid - 13 g, vit. K ¬ 3 to 2.5 g, folic acid - 1g, antioxidant – 100.000 mg and vehicle qsp – 1.000 g.
[2] Manganese, 75.000 mg, iron, 50.000 mg, zinc, 70.000 mg, copper, 8.500 mg, cobalt, 200 mg, iodine, 1.500 mg and vehicle qsp 1.000 g.
[3] Butylated Hydroxy Toluene.

RESULTS

The performance results for initial and growth periods are detailed in table 3. In the initial period from 1 to 21 days of age, crude protein levels did not influence ($p>0.05$) the feed intake, the weight gain and the feed conversion of chickens Redbro.

For the growth period (22 to 42 days), the reduction of crude protein did not affect ($p>0.05$) the feed intake and weight gain of free-range chickens.

Table 3. Means and standard deviation for feed intake (FI), weight gain (WG) and feed conversion (FC) of chickens free-range of the Redbro line, that received decreasing levels of dietary crude protein during the initial periods (1 to 21 days) and growth (22 to 42 days).

Initial Period (1 to 21 days)							
Crude Protein Reduction (%)							
Traits	**21.5**	**21.0**	**20.5**	**20.0**	**19.5**	**P value**	**CV (%)**
FI(g)	929 ±46.39	921 ±43.91	889 ±49.66	898 ±29.00	922 ±64.69	0.33	5.34
WG(g)	519 ±16.83	477 ±18.19	503 ±10.87	516 ±16.75	476 ±27.91	0.31	3.81
FC(g/g)	1.789 ±0.06	1.931 ±0.07	1.766 ±0.08	1.740 ±0.02	1.938 ±0.11	0.28	4.23
Growth Period (22 to 42 days)							
Crude Protein Reduction (%)							
Traits	**19.0**	**18.5**	**18.0**	**17.5**	**17.0**	**P value**	**CV (%)**
FI(g)	2.322 ±0.04	2.336 ±0.03	2.311 ±0.06	2.372 ±0.03	2.354 ±0.03	0.25	1.77
WG(g)	1.110 ±0.04	1.121 ±0.07	1.088 ±0.04	1.104 ±0.02	1.056 ±0.07	0.14	4.83
FC(g/g)[1,2]	2.094 ±0.06	2.091 ±0.14	2.126 ±0.07	2.148 ±0.02	2.239 ±0.18	0.02	5.23

CV = coefficient of variation.
[1]Linear model: FC= 3.4001–0.0699CP (R^2=0.82).
[2]Linear Response Plateau model: FC= 2.0928-0.1125(CP–18.206) (R^2=0.36).

For the feed conversion (FC) was observed significant effect ($p<0.05$), and adjusted by models linear and LRP. By the estimate provided by the LRP model, with the level 18.206% of CP obtains the better feed conversion of the birds, and from this level on, it will not occur changes in responses, accord this model.

DISCUSSION

In the present study was evaluated the reduction of crude protein without altering the ratio of essential amino acids of free-range chickens. Feed intake, weight gain and feed conversion were analyzed with to understand the action of protein crude on performance of the birds.

The data show for the initial phase from 1 to 21 days of age, that the crude protein reduction did not influence the evaluated characteristics. These results demonstrated that it is possible to lower the dietary level of the protein in the initial phase to 19.5% as long the formulation is based on essential amino acids. Lack of effect can be justified by the fact that although the rations having different levels of crude protein, it was held the minimum relation of lysine with the other essential amino acids in all levels studied. This procedure can characterize the utilization of the essential amino acids at the expense of crude protein.

According to Diambra and Mccartney (8), birds submitted to ration with reduced protein levels tend to increase the intake in an attempt to compensate for possible deficiencies in protein and or amino acids. This fact was not observed in this study, possibly because of proper supplementation with essential amino acids. Thus, there was not wide variation in the results, justifying that chickens free range, as well like other lineage of birds, need require the minimum essential amino acids and not only crude protein.

Similar results were found by Rocha et al (9) evaluating protein levels for chickens in phase 1 to 21 days of age, didn't find significant differences for weight gain and feed conversion. However, they observed an increase in feed intake a level of 20% in relation to the level of 23%. Thon et al (10) evaluating different levels of crude protein and arginine in the diets of chickens from 1 to 14 days, observed better weight gain, with the highest protein level (22%) studied. Vasconcellos et al (11) observed a reduction in broiler performance during the initial phase when they reduced levels of protein from 23 to 17%, suggesting that supplementation with essential amino acids was not sufficient to meet the requirements of animals.

To measure the effect of low protein ration on the performance and body composition of chickens in the initial phase, Bregendahl et al (2) noted that chicks fed with low protein ration grew more slowly and use the food less efficiently, however, excreted less nitrogen in the environment, having been reported this positive effect.

The reduction of the crude protein in the grower phase did not influence the weight gain and the feed intake. There was significant effect for feed conversion with better the crude protein level of 18.20%.

These results demonstrate that feed formulation based on the ideal protein concept, with adequate supplementation of industrial amino acids, is able to guarantee the performance of broilers of slow growing lineage at this stage.

Similar results were found with Costa et al (12) studying diets with different levels of CP (19.5 to 17.5%) for broilers from 22 to 42 days, no observed significant differences on weight gain, suggesting that for this variable the levels can be reduced to 17.5%.

Similarly, Nagata et al (13) found positive results when reduced levels of protein in the diets of broilers in the finishing phase, where diets were supplemented with amino acids and enzyme phytase. However, Leandro et al (14) evaluating

different nutritional plans and crude protein levels (18.50, 17.77, 16.95 and 16.68%) and metabolizable energy, they showed that broilers had better weight gain and feed conversion, up to 39 days of age, with increased levels of protein.

According Silva et al (15), the fact that birds do not reach optimal performance consuming diets with low levels of CP has been attributed to factors such as low levels of potassium or ionic balance changed due to the decreased amount of soybean meal in these diets (food which is the principal source of potassium); lack of sufficient pool of nitrogen to carry out the synthesis of non-essential amino acids. Further, the imbalance between certain amino acids such as arginine and lysine, or branched chain amino acids; possible toxic levels of certain amino acids; and inadequate ratio of tryptophan and other neutral amino acids (isoleucine, valine, leucine, phenylalanine, and tyrosine residues), which can inhibit food intake.

The authors Mendoza et al (16) found that the feed cost was higher for those raised in the ideal protein concept, however, because they have provided greater weight to broiler chickens had lower costs per gain being 3.5% better.

It is common to get information from the literature in which authors reported a possible reduction in costs when evaluating diets the ideal protein concept. Moreover, lower levels of crude protein and supplementation with essential amino acids can have beneficial effects with the greatest retention of nitrogen, thereby reducing environmental pollution (2).

Protein levels for the chickens of the Redbro line can be reduced to 19.5% for the initial phase (1 to 21 days) and 18.20% for the growth phase (22 to 42 days) without affecting the zootechnical performance, provided that the ideal proportion of amino acids- digestible lysine is met and the requirements of the limiting amino acids are maintained.

Conflict of interests.

The authors declare no conflict of interest with publication of this manuscript.

Acknowledgments

We thank the Research Foundation of the State of Minas Gerais (FAPEMIG) for financial support and Ajinomoto of Brazil Industry and Food Trade Ltda the donation of the amino acids, and appreciation to professor Aldrin Vieira Pires (*in memoriam*) for his contribution in this study.

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